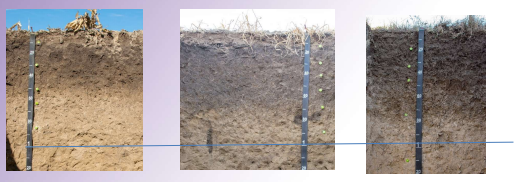
Building Better Soils



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Defining soil health

- Defined as: The capacity of a soil to function
- Measurable physical, chemical, biological properties
- Is organic matter a P, C, or B property?
- Yes
- How long does it take to change?

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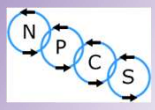
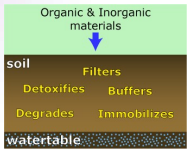
What's a soil function?



Cycle nutrients

Water relations

Diversity and habitat



Filter and buffer

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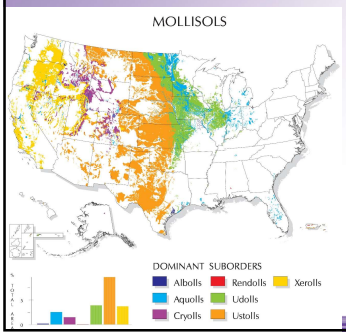
Where do soils come from?



- 5 soil forming factors
- Climate
- Organisms
- Relief
- Parent material
- Time

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What's the different between the two photos? Hint: 150 years.

Cropland 40-60% eroded relative to adjacent pasture, NE KS

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Soil Health Definition

- "The capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health" (Doran and Zeiss, 2000).

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- Good news: Past research says we can improve soil health
- Information about soil high in demand by farmers and agronomists
  - Productivity?
  - Water?
  - Weeds?
  - How fast will my soil change?

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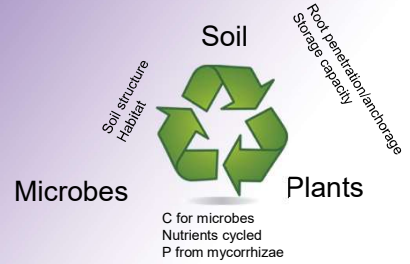
Complex, beneficial relationships



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Overview

- Importance of soil physical properties
  - Precipitation capture and storage
- Physical soil properties we can measure
- Reversing the effects of soil degradation

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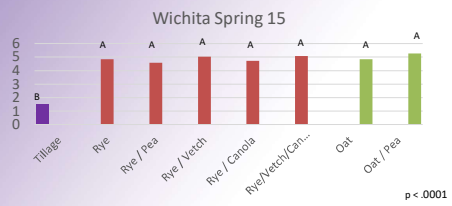
Soil Physical Properties
Mean Weight Diameter (mm)



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Wet aggregate measurement illustrated

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Wet aggregate measurement illustrated

12

Wet aggregate measurement illustrated

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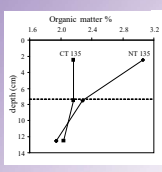
Relationships: Organic matter is key



- Both soils received the same N rate for 30 years
- One tilled, other not tilled

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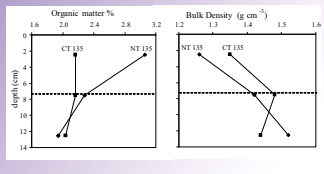
Relationships: Organic matter is key



- Both soils received the same N rate for 30 years
- One tilled, other not tilled

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Bulk density

- Soils with more organic matter have better aggregation
- Better aggregation means less compactable
- Excavate a known volume of soil and determine dry mass

Table 1. Average minimum bulk densities that restrict root penetration in soils of various textures.

Texture	Bulk Density g/cc
Coarse, medium, and fine sand	1.80
Loamy sand and sandy loam	1.75
Loam and sandy clay loam	1.70
Clay loam	1.65
Sandy clay	1.60
Silt and silt loam	1.55
Silty clay loam	1.50
Clay	1.40

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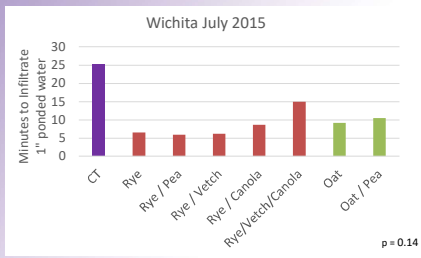
Infiltration: Movement of water into soil



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Study 1: Long-term, 27.5", silty clay soil (lots of smectite)

Winter wheat-Grain sorghum rotation

15 years

Summer legume after wheat options:

Sunn hemp

Crotalaria juncea

Alternatives:

Cowpea, soybean, mungbean

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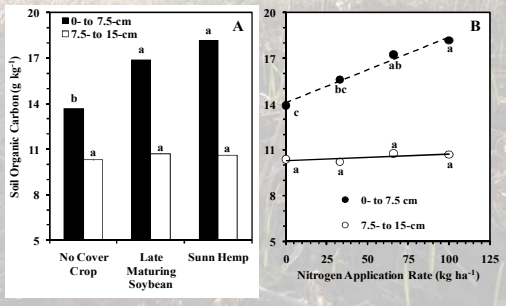
After 15 years, 0-3" SOC differed



Blanco-Canqui, H., Claassen, M. M., & Presley, D. R. (2012). Summer cover crops fix nitrogen, increase crop yield and improve soil-crop relationships. Agronomy Journal, 104(1), 137-147.

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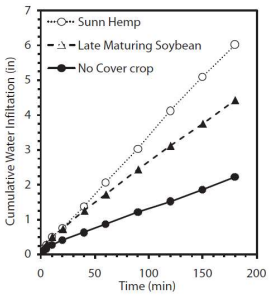
More SOC, Faster Ponded Infiltration



150 mm

100 mm

50 mm

- Infiltration: Movement of water through the surface]
- Double-ring
- Precipitation capture and storage is CRITICAL in semi-arid cropping
- Cover crops planted every other year

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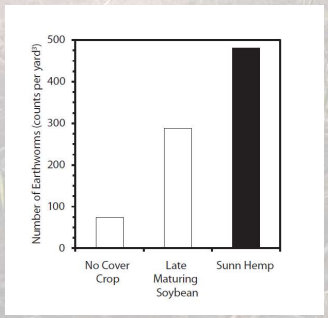
Or maybe it was the worms?



- Measured worms by digging up soil in December 2009 in grain sorghum stalks.
- How long had it been since the covers were green and living?
- About 13-14 months. Worms *still* preferred the cover crop plots.

"Worms prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings of all kinds." Charles Darwin, 1881

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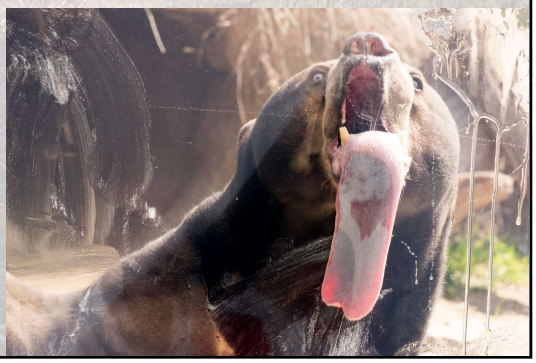
Don't feed the bears!



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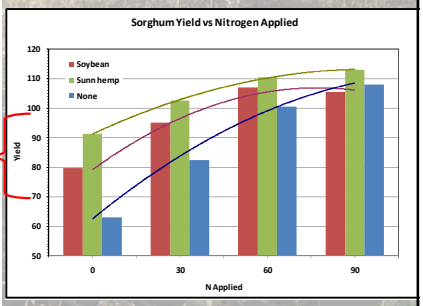
Better Soils Were Actually More Productive Too

Notice the yield boost with no applications of N.

The boost comes from improvements in soil productivity.

For sunn hemp, this persists, even with increasing N.

Is it high enough with N credit to cover establishment costs?



Units are bushels and pounds

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Nice ongoing work in western KS being done by Augustine Obour and John Holman

Simon, L. M.; Obour, A. K.; Holman, J. D.; and Roozeboom, K. L. (2020) "Long-Term Cover Crop Management Effects on Soil Health in Semiarid Dryland Cropping Systems," *Kansas Agricultural Experiment Station Research Reports*: Vol. 6: Iss. 5. https://doi.org/10.4148/2378-5977.7927

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Methods

- Garden City
- Four treatments:
  - Fallow
  - Pea (grain)
  - CC standing
  - CC hayed
- Measured:
  - Bulk density and soil organic C
  - Multiply the BD, the SOC, and depth = SOC in tons/ac
  - This is important! Because the % SOC is misleading, and this is really the best way to know if you are really storing C (example, C trading)

11-22-2015
Rye, rape, winter pea

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Table 2. Cover crop management effect on bulk density (BD) and soil organic carbon (SOC) stocks in the 0- to 6-inch soil depth in spring 2012, fall 2018, and summer 2019

Treatment	Spring 2012		Fall 2018		Summer 2019	
	BD	SOC	BD	SOC	BD	SOC
	g/cm³	tons/acre	g/cm³	tons/acre	g/cm³	tons/acre
Fallow	1.49 a†	8.33 a	1.48 a	9.36 a	1.39 a	8.71 a
Pea (grain)	1.40 a	9.20 ab	1.39 b	9.61 a	1.39 a	9.19 a
Cover crops (standing)	1.47 a	9.29 b	1.41 b	9.80 a	1.39 a	8.73 a
Cover crops (hayed)	1.45 a	8.85 ab	1.43 ab	9.79 a	1.40 a	9.10 a

†Means with the same lower-case letter within the same column are not significantly different among management scenarios.

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Table 4. Effect of cover crop management on mean weight diameter (MWD) of wet aggregates from the 0- to 2-inch soil depth in fall 2018 and summer 2019

Treatment	Fall 2018	Summer 2019
	MWD	
	Inches	
Fallow	0.033 ab†	0.082 a
Pea (grain)	0.030 b	0.070 a
Cover crops (standing)	0.044 a	0.090 a
Cover crops (hayed)	0.042 ab	0.080 a

†Means with the same lower-case letter within the same column are not significantly different among management scenarios.

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Table 5. Cover crop management effect on wet aggregate size distribution for the 0- to 2-inch soil depth in fall 2018 and summer 2019

Sample period	Treatment	< 0.01-in.	0.01- to 0.04-in.	0.04- to 0.08-in.	0.08- to 0.30-in.
		Percent of each size fraction			
Fall 2018	Fallow	23 a†	45 a	8 a	24 ab
	Pea (grain)	30 a	41 ab	8 a	21 b
	Cover crops (standing)	26 a	32 b	6 a	37 a
	Cover crops (hayed)	23 a	33 ab	7 a	37 a

- More large aggregates, which is helpful for erosion and water infiltration
- Need to capture and store precip when it comes

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Data from the HB ranch outside of Hays

Obour, A. K.; Holman, J. D.; Simon, L. M.; and Johnson, S. K. (2020) "Dual Use of Cover Crops for Forage Production and Soil Health in Dryland Crop Production," *Kansas Agricultural Experiment Station Research Reports*: Vol. 6: Iss. 5. https://doi.org/10.4148/2378-5977.7930

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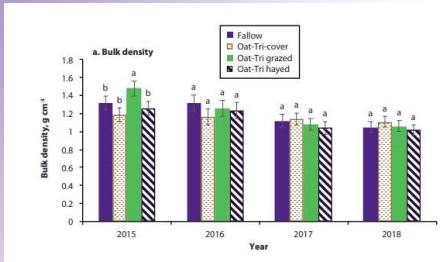
No negative effects on BD



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Soil Organic C %

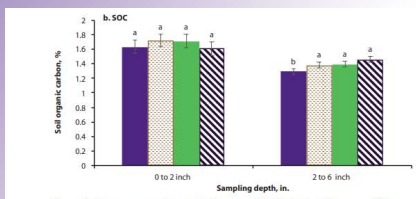

Figure 2. Cover crop management effect on soil bulk density (a) measured from fall 2015 to 2018 and soil organic carbon (b) measured in 2019 at the Kansas State University experiment fields at HB Ranch near Brownell, KS. Bars followed by the same letter(s) are not significantly different ($P < 0.05$).

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DIY: SLAKES app

- Google Play store only
- Free app
- Take photos of your own soil falling apart in water
- I'll be trying it out this winter
- Early but promising

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Conclusions

- Some properties are slow to change, like soil organic matter
- Could see more immediate results for reducing erosion losses
- "Fixing" the surface is so important for precipitation capture and storage, starting with aggregate stability
- Building soil health is a long-term investment for feeding the world

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Questions?

Winter Cover Crop cocktail seedlings 2.5 weeks after planting. Oats, tillage radishes, lupin, winter peas, cereal rye.

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